Performing Creativity With Computational Tools

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Abstract

The introduction of new tools in people's workflow may promote new creative paths. This article discusses the impact of computational tools on performing creative tasks. The study was conducted by a set of semi-structured interviews made to twelve professionals working on graphic design, data science, computer art, music and data visualisation. The results suggest scenarios in which it may be worth investing in the development of creativity-enhancing tools, as well as scenarios where such endeavour is not promising.

Introduction

Looking backwards at the history of humanity or making a retrospective into our daily creative practices, it is noticeable that the use of different tools may introduce new creative possibilities. This study aimed to understand how creativity may be impacted by the introduction of computational tools, by studying and comparing non-computational, creativity support, and Computational Creativity (CC) tools (co-creative and fully autonomous). To achieve this, a set of semi-structured interviews were made with professionals working on Graphic Design (GD), data science, computer art, music and data visualisation. Most were experienced in more than one area. Despite including several creative areas, the research was primarily focused on GD. The answers were analysed and discussed to summarize the insights.

The remainder of this paper is organised as follows. The Background section presents a brief review of the literature regarding (i) creativity and the evolution of design tools (computational and non-computational); (ii) creative systems outside the design field; and (iii) studies on enhancing creativity. The Interviews section describes the research and discusses the results. Conclusions and Future Work summarises the work and presents future research directions.

Background

Novelty is one of the fundamental characteristics to define creativity (Boden 1996) and it may be achieved by exploring or extending the existing space of possibilities (Veale and Cardoso 2019). The introduction of the movable types by Gutenberg in the 1450s and the *Unigrid* system by Massimo Vignelli in 1977 (Philip B. Meggs 2016) are historical examples of extending the creative space by introducing new tools. Recently, the digital revolution brought new design tools and fostered new design movements (Lupton 2014). Additionally, the present design era made of dynamic and participatory designs has been fostering novel solutions such as animated and reactive design artefacts (Shaughnessy 2012).

Concurrently, academics and practitioners started to explore Artificial Intelligence (AI) as a creative tool, establishing the Computational Creativity (CC) area — *"an emerging branch of* AI *that studies and exploits the potential of computers to be more than feature-rich tools, and to act as autonomous creators and co-creators in their own right."* (Veale and Cardoso 2019). CC tools may be co-creative or fully autonomous. The first collaborate with humans in creative tasks, while the second generate creative artefacts without human assistance (Maher et al. 2018). Nevertheless, both have been successful aiding creativity, for instance, in areas such as computational art (Romero and Machado 2007; Machado et al. 2014), music (Miranda and Biles 2007) or design (Rebelo et al. 2018), by applying evolutionary (Romero and Machado 2007) or machine learning techniques (Machado, Romero, and Manaris 2007; Elgammal et al. 2017).

Besides art and design, creativity may be necessary in fields such as engineering. According to Robertson and Radcliffe (2009), engineers may be both positive and negatively influenced by creativity support tools, since these may provide (i) better ability to visualise and communicate ideas within the work team; yet these may also cause (ii) technical difficulties to make major changes in the projects as these get more complex; and (iii) limited creative possibilities imposed by the constraints of the tools. The authors argued that using computational tools may not be the best approach to generate ideas, yet these may be helpful to complement the human creative process.

Work on creativity-enhancing frameworks has also been done. Nickerson (1999) presented a framework composed of twelve steps for teaching creativity and CC tools may be used for accomplishing some of these. For instance, (i) *"providing opportunities for choice and discovery"* or (ii) *"strategies for facilitating creative performance"*.

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Shneiderman and Plaisant (2010) referred guidelines for developing creativity support tools, such as making them (i) *"low threshold, high ceiling, and wide walls"*, (ii) collaboration supportive, (iii) *"as simple as possible"* and (iv) able to *"iterate, iterate, then iterate again"*. CC tools may also fit in these guidelines, suggesting that its development may be desirable as well.

Research Approach

This study aimed to understand (i) the impact of computational tools in creative tasks, mainly focusing on GD; and (ii) whether or not the insertion of new tools (computational or not) would enlarge the creative possibilities (opening new paths to explore in different directions). Assuming that new tools are favourable for enlarging the creative spectrum, computational tools may also do so. In that sense, creativity support and CC tools (co-creative and fully autonomous) were studied.

Semi-structured interviews followed by axial content analysis (guided by subquestions) revealed to be an adequate method to address the goals of this study, providing clear strategies for organizing data-gathering, coding and analysis. Audio-recorded face-to-face interviews were conducted so all the nuances of participants' language could be addressed. Due to the nature of this research, only people who have worked with creativity-enhancing tools were included — 12 designers and computer artists (3 women and 9 men) working at the University of Coimbra (Portugal), from 26 to 61 years old with diverse backgrounds: (i) 3 seniors graphic designers; (ii) 2 senior CC researchers (iii) 3 PhD students researching on CC applied to graphic design; (iv) 2 PhD students researching on data visualisation; (v) 1 PhD student researching on data science and (vi) 1 PhD student researching on GD. The interviews took 15 to 30 minutes and were semi-structured by previously setting a list of 10 open-answer questions. If an answer has responded to some further questions, these were accordingly altered or skipped to avoid repetition.

Interview Analysis

To understand how the computational tools may influence creativity, the research goal was decomposed in subquestions that motivated content analysis: (i) do computational systems influence the creative process; (ii) is it worth investing in the development of creativity-enhancing computational tools; and (iii) how may CC tools be useful in the creative process. Therefore, the themes were organized under the following categories: (i) Creative process and creativity; (ii) Creativity-enhancing tools and their advantages; and (iii) CC tools.

Creative process and creativity

The first questions of the interviews aimed to understand the differences in the backgrounds of the respondents, so these were asked to describe the stages of their workflow and pinpoint the ones requiring creativity.

From the content collected, the following common stages were identified: (i) understanding the problem and the project requirements; (ii) searching existing work; (iii) combining solutions for getting a new result. Additionally, it was consensual that the interpretation of the problem and prior experiences/knowledge (which may be influenced by the context one lives in) may influence the outcome. It was also consensual that all the stages of the workflow may require creativity.

Moreover, two respondents argued that even searching may imply creativity, not only to find a better search method but also to find the best search domain. Two other respondents believed that most of the creative effort regards the implementation stage, and one other claimed the requirements-gathering stage may be the one involving less creative effort. More, it was assessed that creativity may also come from outside the work process. For example, occasionally observing natural events or daily routines.

Creativity-enhancing tools and their advantages

The second group of questions was related to the use of computational and non-computational tools and aimed to assess: (i) which tools were used the most; (ii) whether and how these were helpful in the creative process; and (iii) how computational and non-computational tools may differ and in which contexts these may be used.

The answers revealed that all the respondents frequently used computational tools in their creative process. Also, part of them claimed to use creativity support, version-control and planning tools during the implementation phase. Most believed that such tools were highly advantageous, for example, by speeding up processes or fostering exploration, allowing otherwise unthinkable solutions. Also, some claimed that the introduction of computational tools brought control over the entire workflow, by allowing one to go back and forward in the developments. One respondent argued that computational tools may provide a basis for starting or unlocking creative blocks, and others referred to the benefit of the internet on improving team collaboration and community support and providing easy access to new tools. Also, thanks to the easy access and the facility of creation, some declared themselves dependent on some tools.

Even so, most respondents still use analogue methods such as books for researching or paper for fast sketching, and some noted that when using analogue methods, the process of execution and exploration needs to be better reflected. Most of the respondents added that the project and its needs may define the tools that are the most advantageous, and a PhD student working on CC claimed that the combination of computational and non-computational tools may be an asset to generate more experimental and less standard results.

Computational creativity tools

The final set of questions of the interviews regarded CC tools, and aimed to understand whether or not (i) CC tools may be useful in the creative process (may one be inspired in machine's outputs as one does by people's work); (ii) can people use these in real use scenarios; (iii) is it worth the investment in research and development of such tools.

Most respondents have expressed their interest in CC tools and believed that these may never replace human creativity,

but complement it by increasing each others' capabilities. Yet, there has been a higher interest in co-creative tools over fully autonomous ones. Some admitted having used CC tools due to curiosity, to automate tasks, or to access new functionalities, yet mostly to explore novel solutions.

From the above, one may infer that CC tools may foster new creative paths. Even so, some considerations were referred: (i) such tools may be more effective on objective-evaluation issues; (i) CC systems may be picked or adapted according to the projects; (iii) most defended that humans may always guide the process, yet others claimed that having machines replacing some human creative tasks may not be a negative thing, once people may adapt and direct their capabilities to more unexplored creative tasks.

Conclusions and Future Work

To collect perspectives on how computational tools may affect human creativity, a set of semi-structured interviews were conducted with people working on creative fields such as graphic and computational design. The questions aimed to cover the creative background of the respondents, understand what and how the tools were used and, finally, collect their thoughts on CC tools. After coding and classifying answers' content into themes, further analysis led to sum up the insights along key research sub-questions.

The answers revealed that the creative process may not be mainly shaped by the computational tools themselves but rather by social and personal background knowledge, which may change the interpretation of the problem.

Yet, especially in early stages, the increasing productivity related to the use of new CC tools may be claimed as well-established evidence, once these may amplify the exploration and velocity of the processes. Moreover, these may bring higher levels of confidence on the user, by permitting to revise and reformulate earlier developments without disabling further ones.

Also, the respondents agreed that exploring new tools may expand creative possibilities, leading to new solutions. For instance, exploring both analogical and computational tools is recommended.

When questioning the role of CC tools in the creative process, the respondents showed their interest in co-creative tools and referred to their value for searching for unexpected solutions. Some divergence surfaced regarding fully-automatic tools, once many fear human replacement. Others think it may be a natural way for humans to move their efforts forward to unexplored creative tasks.

In sum and paraphrasing a respondent, all professions, processes of thinking and execution evolve and mutate in accordance with the evolution of their tools. Furthermore, personal background and experiences may have a strong impact on the employment of creativity, namely, due to social and cultural reasons.

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